males, fighting with any intruder for all he is worth. With the physiological change (partly due to specific internal secretions contributed to the blood-stream) there is a complete psychical change in the dispositional attunement of the bird's nature. Substantially the same presentation afforded by another male is now linked with quite different modes of overt behaviour. No longer gregarious, he is a solitary occupant of a restricted domain, driving all other males away. Presently he is joined by a mate, and the normal routine of reproduction runs its course. But if a cold snap should come on, the separated males may reunite in a flock, and the male is then no longer intolerant of other males. The physiological state probably reverts to its winter poise, and with this is correlated a reversion to the previous psychical disposition. But it seems that when a male bird (lapwing or other) has secured a territory and is intolerant therein of all others save a mate, he sometimes returns for a while to the flock which occupies a neutral area. *There* he is no longer intolerant of others, but moves among them on quite friendly terms. Hence in different circumstances, (1) in his territory and (2) in the flock, his disposition is different, so that occupancy of a territory appears to be a determining condition of the behaviour observed therein. If this sort of thing occurred in so marked a form in human life, it would perhaps be attributed to "dissociation," and described as an instance of double personality, two "streams of consciousness" being separated as if by a barrier. In any case, just thus, it seems, does the male bird in his first year behave, though he has never so behaved before, or seen others so behave.

Exigencies of space preclude more than an outline sketch of Mr. Howard's main thesis. The treatment in detail is admirable in its method of raising and meeting difficulties with no attempt to shirk them. The way in which the expression of song may produce a different impression on others at different times and in different circumstances is dealt with suggestively. All may not agree with Mr. Howard's conclusions; but all will admit the transparent candour of a genuine seeker after truth. One would like to comment on his contribution to the solution of the difficult problem of migration—turning upon the alternating interplay between the territorial and the gregarious poise in disposition. But lack of space forbids. The book is well written, well printed, and well illustrated, with photogravures from drawings by Mr. G. E. Lodge and Mr. H. Grönwold.

C. LL. M.

Airscrews in Design and Performance

Airscrews in Theory and Experiment. By A. Fage. Pp. ix + 198 + 7 folding plates. (London: Constable and Co., Ltd., 1920.) Price 34*s.*

IT is difficult to place this book in the scheme of aeronautical progress, for it does not deal adequately with either the theory or the practice of airscrew design. The author has not succeeded in the idea expressed in the first sentence of his preface, where he says that "an endeavour has been made to present in this work an accurate and comprehensive account of the science of the airscrew from both its theoretical and experimental aspects." It is well known to all those connected with the experimental side of aeronautics that Mr. Fage, as a result of his position at the National Physical Laboratory, has had greater facilities for original work than any other British worker. The number of papers in his name which occur in the bibliography testifies to his activities, and the book cannot fail to have an importance in many directions. One would select chaps. v., vi., and vii.—that is, those dealing with experimental data—as justifying the writing of this book.

What is missed is the presentation of the results of research in a form which stimulates application to the workaday theories of the immediate future. Instead, one finds a very important recent development of theory compressed into one and a half pages of the book in such a way that, without prior knowledge, it conveys nothing to the reader. The basic theorem on which design rests comes from the conception that the several elements of an airscrew blade produce an airflow which is essentially of the same character as the flow round a wing. The application of this theory to aerial propellers is due to Drzewiecki and Lanchester, but after some little use and comparison with experiment it was found to be insufficiently accurate for design purposes. The necessary idea for a next approximation was obtained from a realisation of the fact that a wing is always moving into fresh air, whilst an airscrew blade moves into air disturbed by other blades and by the previous passages of the blade itself. The thrust of an airscrew, being produced by dynamic means, involves the throwing back of a mass of air per second the axial momentum of which is equal to the thrust. Owing to the continuity of the airflow, it might therefore be expected that disturbances due to other blade passages would take the form of an "inflow" of air into the airscrew blade. Experiment provides support for, and can be used to give quantitative values to, a theory based on this idea.

In discussions of marine propellers, Froude

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developed a theory in which half the final momentum of the slip stream was added in front of the propeller disc. Lanchester applied the idea to aerial screws, but, with his sense of the physical incompleteness of the theory, he did not accept "half" as anything more than an approximation. The Fage-Collins theory referred to on p. 19 is merely a theory which supposes that wing elements modified by the assumption of an inflow velocity can be made to agree with an experimental check by the choice of a certain constant closely related to Froude's half.

It is known that a second approximation so made is important, but it is also realised that every unknown quantity, such as the effect of the ends of the blades, their shape, and the changes in type of flow due to centrifugal action, are attributed to inflow. Wood and Glauert devised a scheme for the experimental determination of "inflow" without the above complications, and described their tests in the report referred to by Mr. Fage. It was pointed out that a logical extension of the aerofoil theory would be obtained by placing a succession of aerofoils behind each other in a wind channel so that some of them were working in the disturbed air of blades further into the wind. The relative positions of the blades to correspond with an airscrew were not found to be inconvenient for experiment, and, finally, after tests in a wind channel, a further approximation was made which brought theory nearer to the truth. The differences from the Fage-Collins theory are too great to be dismissed as unimportant, and show that there still remain further factors to be investigated.

This fundamental step in analysis of airscrew performance is the one dismissed by Mr. Fage in less than two pages of his book, and his closing remarks indicate the rather illogical contention that because other points still remain to be explained, the new experiments are of little use. This should surely not be the attitude of research workers at the National Physical Laboratory. It is to be hoped that it does not represent the views of the late Advisory Committee for Aeronautics, to which most of the items of work at the National Physical Laboratory were presented before publication.

This example has been taken at some length as typical of the book, which, on the theoretical side, is sketchy throughout. Perhaps one is tempted to be too critical of a work which largely records war activity. On the other hand, where are we to look for the progressive development of knowledge in aeronautics if such places as the National Physical Laboratory fail us? Is the new Aeronautical Research Committee still accumulating a great mass of undigested material, of which Mr. Fage's contribution is a part, or is it keeping its activities for advice on the general lines of experiment and research? One is not too hopeful that the incubus of the war is being thrown off any more completely by his employers than by the author of the book under notice.

Nomography.

A First Course in Nomography. By Dr. S. Brodetsky. (Bell's Mathematical Series. Advanced Section.) Pp. xii + 135. (London: G. Bell and Sons, Ltd., 1920.) Price 10*s.* net.

THE subject of nomography may be shortly described as dealing with the graphic representation of formulæ. As developed by M. d'Ocagne, there has been an increasing interest taken in recent years in the application of its methods to facilitating calculation in engineering and scientific work generally.

In this "First Course," nomography is arbitrarily restricted to graphic representation in parallel co-ordinates, the resulting diagram being read by the collineation of points. It is true that there is a growing tendency to use the word "nomogram" for such a representation only; but, apart from nomenclature, there are grave disadvantages in this isolated treatment.

For a clear and intelligent appreciation of the subject it is a matter of great importance to keep in the forefront the *principle of duality*, the connection between graphic representation in Cartesian co-ordinates (the intersection diagram) and that in parallel co-ordinates (the alignment diagram), and the transformation of the one into the other.

Throughout the book the explanations are clear and the diagrams excellent, but the former appear occasionally to be unnecessarily diffuse. Nearly fifty pages out of a total of fewer than one hundred and fifty are mainly occupied with a minute description of nomograms for performing simple addition and subtraction, a purpose for which they are seldom practically used. Some introductory reference to them is certainly advisable, but all that is necessary might quite well have been given in a few pages and a couple of illustrations.

Some of the space so saved could with advantage have been devoted to a description of the direct-reading four-variable nomogram, which is a combination of two parallel scales and a network. To this no reference is made, but it is of great importance in practical work.

Diversity of notations is a continual source of irritation in such subjects, but, of course, is at

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